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Swan Lake
Lake County, Montana

National Eutrophication Survey, Corvallis, Oreg

Prepared for

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NATIONAL EUTROPHICATION SURVEY

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REPORT

ON

SWAN LAKE

LAKE COUNTY

MONTANA

EPA REGION VIII

WORKING PAPER No. 800

WITH THE COOPERATION OF THE

MONTANA DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

AND THE

MONTANA NATIONAL GUARD

MAY, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U.S. Environmental Protection Agency) express sincere appreciation to the Montana Department of Health and Environmental Sciences for professional involvement, to the Montana National Guard for conducting the tributary sampling phase of the Survey, and to those Montana wastewater treatment plant operators who voluntarily provided effluent samples.

The staff of the Water Quality Bureau provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

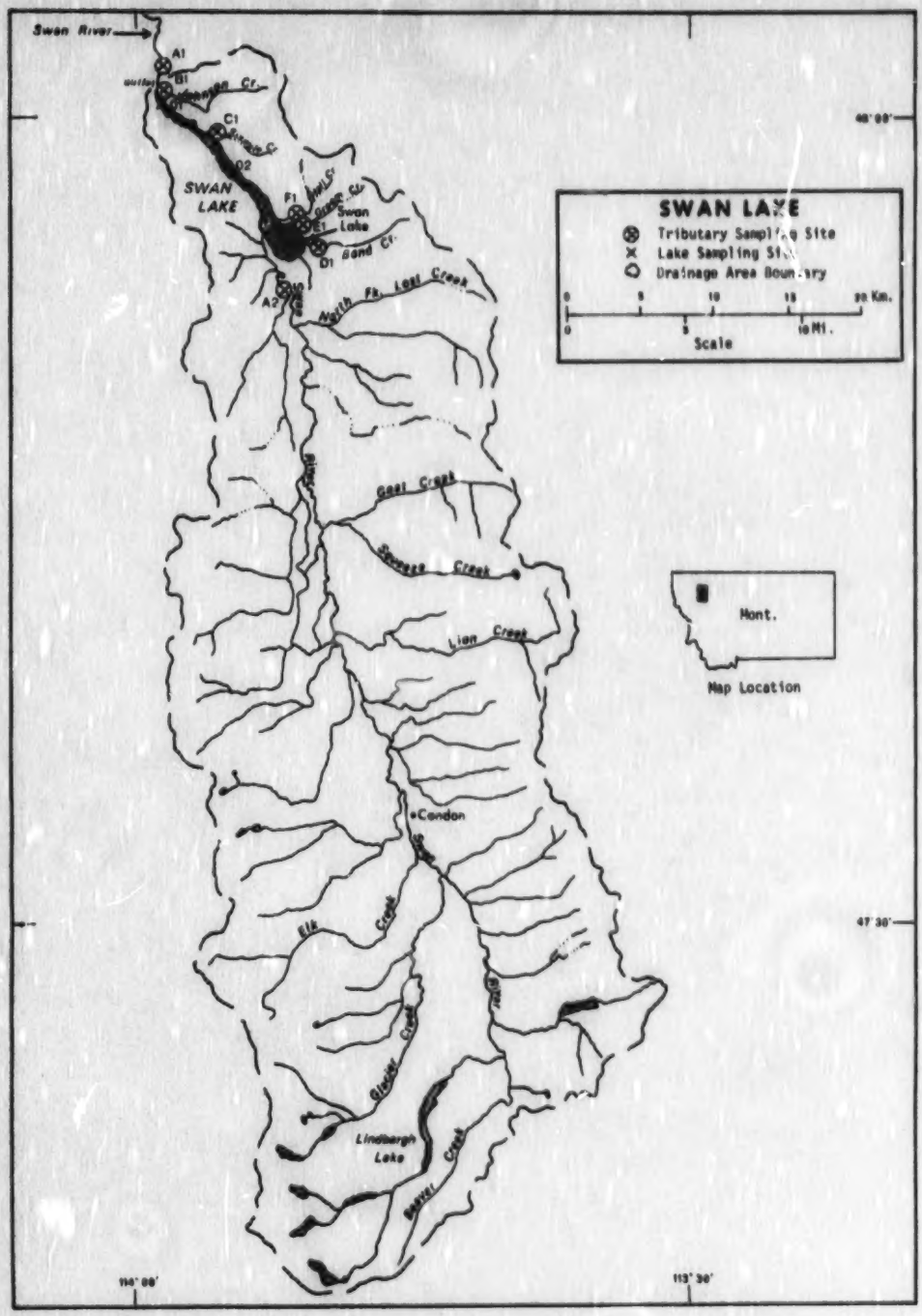
Major General John J. Womack, the Adjutant General of Montana, and Project Officer Major William Yeager, who directed the volunteer efforts of the Montana National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF MONTANA

LAKE NAME	COUNTY
Canyon Ferry	Broadwater, Lewis and Clark
Clark Canyon	Beaverhead
Flathead	Flathead, Lake
Georgetown	Deer Lodge, Granite
Hebgen	Gallatin
Kookanusa	Lincoln, MT; British Columbia, Can.
Mary Ronan	Lake
McDonald	Flathead
Nelson	Phillips
Seeley	Missoula
Swan	Lake
Tally	Flathead
Tiber	Liberty, Toole
Tongue River	Big Horn
Whitefish	Flathead
Yellowtail	Carbon, Bighorn, MT; Bighorn, WY


Swan River
A1
B1
C1
D2
SWAN LAKE
F1
E1
Swan Lake
D1
Sand Cr.
A2
North Fk. Lost Creek
Lost Creek
Squeeze Creek
Lion Creek
Condon
Elk Creek
Glacier Creek
Lindbergh Lake
Beaver Creek
48°00'
47°30'
114°00'
113°30'
SWAN LAKE
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0 5 10 15 20 Km.
0 5 10 Mi.
Scale
Mont.
Map Location

SWAN LAKE

STORET NO. 3011

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Swan Lake is mesotrophic. It ranked fifth in overall trophic quality when the 15 Montana lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. Three of the water bodies had less median total phosphorus, two had less and three had the same median orthophosphorus, five had less and three had the same median inorganic nitrogen, eight had less mean chlorophyll a, and two had greater mean Secchi disc transparency. No significant depression of dissolved oxygen occurred at depths as great as 25.9 meters.

Survey limnologists observed emergent macrophytes in the north and south ends of the lake near stream confluences.

B. Rate-Limiting Nutrient:

Because of significant nutrient changes in the samples during shipment from the field to the laboratory, the algal assay results are not considered representative of conditions in the lake at the times the samples were taken.

The lake data indicate nitrogen limitation in June and phosphorus limitation in July and September.

C. Nutrient Controllability:

1. Point sources--No known wastewater treatment plants impacted

* See Appendix A.

Swan Lake during the sampling year. Septic tanks serving lakeshore dwellings and a campground added an estimated 0.3% of the total phosphorus load to the lake, but a shoreline survey is needed to determine the actual significance of those sources.

The present phosphorus loading of 1.56 $g/m^2/yr$ is within the range proposed by Vollenweider (Vollenweider and Dillon, 1974) as a mesotrophic loading (see page 11). Because of this, all phosphorus inputs to Swan Lake should be minimized to the greatest practicable extent to maintain the present trophic quality of the lake.

2. Non-point sources--Non-point sources, including direct precipitation, accounted for 99.7% of the total phosphorus load to Swan Lake during the sampling year. The Swan River contributed 85.7% of the total load; Johnson Creek, 0.3%; Bond Creek, 1.0% Hall Creek, 0.6%; and the ungaged tributaries added an estimated 11.0% of the total.

The phosphorus export rates of the Swan River, Johnson Creek, Bond Creek, and Hall Creek were 10, 2, 9, and 9 $kg/km^2/yr$, respectively (see page 10). Except for Johnson Creek, these export rates are somewhat higher than those of the tributaries of nearby Flathead Lake* (mean of about 4 $kg/km^2/yr$).

* See Working Paper No. 792.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 10.85 kilometers^2.
2. Mean depth: 21.9 meters.
3. Maximum depth: 40.2 meters.
4. Volume: 237.615 x 10^6 m^3.
5. Mean hydraulic retention time: 85 days (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Swan River	1,416.7	32.310
Johnson Creek	31.3	0.183
Bond Creek	19.6	0.477
Hall Creek	12.1	0.358
Minor tributaries & immediate drainage -	247.3	1.010
Totals	1,727.0	34.338

2. Outlet -

Swan River	1,737.9**	32.390

C. Precipitation***:

1. Year of sampling: 51.4 centimeters.
2. Mean annual: 57.8 centimeters.

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† Table of metric conversions--Appendix B.
†† Horpestad, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Swan Lake was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 17.1 meters at station 1, 18.6 meters at station 2, and 25.9 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR SWAN LAKE
STORET CODE 3011

PARAMETER	1ST SAMPLING (6/ 2/75) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (7/28/75) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (9/ 5/75) 3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	4.3 - 11.5	8.7	9.5	3.9 - 18.2	12.9	14.7	7.8 - 15.9	13.8	15.1
DISS OXY (MG/L)	9.2 - 10.0	9.7	9.8	5.4 - 9.0	8.1	8.2	6.0 - 9.2	8.1	8.8
CNDCTVY (MCROMO)	114. - 130.	124.	124.	104. - 130.	118.	119.	119. - 147.	130.	129.
PH (STAND UNITS)	7.8 - 8.2	8.1	8.1	7.6 - 8.3	8.0	8.1	7.1 - 8.4	8.0	8.1
TOT ALK (MG/L)	59. - 96.	88.	90.	68. - 94.	77.	75.	82. - 92.	86.	85.
TOT P (MG/L)	0.008 - 0.021	0.011	0.010	0.005 - 0.029	0.010	0.008	0.006 - 0.976	0.013	0.010
ORTHO P (MG/L)	0.004 - 0.012	0.009	0.010	0.003 - 0.008	0.004	0.004	0.002 - 0.006	0.002	0.002
NO2+NO3 (MG/L)	0.020 - 0.060	0.041	0.040	0.020 - 0.100	0.034	0.020	0.020 - 0.080	0.027	0.020
AMMONIA (MG/L)	0.020 - 0.030	0.021	0.020	0.020 - 0.030	0.021	0.020	0.020 - 0.020	0.020	0.020
KJEL N (MG/L)	0.200 - 0.500	0.275	0.300	0.200 - 0.200	0.200	0.200	0.200 - 0.300	0.207	0.200
INORG N (MG/L)	0.040 - 0.090	0.061	0.060	0.040 - 0.120	0.054	0.040	0.040 - 0.100	0.047	0.040
TOTAL N (MG/L)	0.230 - 0.520	0.316	0.335	0.220 - 0.300	0.234	0.220	0.220 - 0.320	0.233	0.220
CHLRPYL A (UG/L)	1.0 - 1.7	1.3	1.3	1.0 - 1.5	1.3	1.4	1.8 - 18.0	7.2	1.9
SECCHI (METERS)	2.3 - 3.7	3.0	3.0	5.5 - 5.8	5.6	5.5	6.7 - 7.6	7.1	7.1

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
06/02/75	1. Dinobryon sp.	545
	2. Gymnodinium sp.	95
	3. Cryptomonas sp.	47
	4. Asterionella sp.	47
	5. Melosira sp.	47
	Other genera	72
	Total	853
07/28/75	1. Asterionella sp.	290
	2. Chroomonas sp.	290
	Total	580
09/05/75	1. Chroomonas sp.	238
	2. Cryptomonas sp.	119
	3. Asterionella sp.	119
	4. Cyclotella sp.	40
	Total	516

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/02/75	1	1.3
	2	1.0
	3	1.7
07/28/75	1	1.0
	2	1.5
	3	1.4
09/05/75	1	1.9
	2	18.0
	3	1.8

C. Limiting Nutrient Study:

Because of significant nutrient changes in the samples during shipment from the field to the laboratory, the algal assay results are not considered representative of conditions in the lake at the times the samples were taken (06/02/75 and 09/05/75).

The lake data indicate nitrogen limitation in June and phosphorus limitation in July and September. At those times, the mean inorganic nitrogen to orthophosphorus ratios were 7 to 1, 14 to 1, and 24 to 1, respectively.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Montana National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of June when two samples were collected. Sampling was begun in October, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Montana District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in kg/km^2/year, at stations A-2, B-1, D-1, and F-1 and multiplying the means by the ZZ area in km^2.

No known wastewater treatment plants impacted Swan Lake during the sampling year.

A. Waste Sources:

1. Known municipal - None
2. Known industrial - None

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* See Working Paper No. 175.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Swan River	14,535	85.7
Johnson Creek	55	0.3
Bond Creek	170	1.0
Hall Creek	105	0.6
b. Minor tributaries & immediate drainage (non-point load) -	1,855	11.0
c. Known municipal STP's - None	-	-
d. Septic tanks* -	55	0.3
e. Known industrial - None	-	-
f. Direct precipitation** -	190	1.1
Total	16,965	100.0

2. Outputs -

Lake outlet - Swan River 9,885

3. Net annual P accumulation - 7,080 kg.

* Estimate based on 180 dwellings and one campground; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Swan River	637,945	82.8
Johnson Creek	3,270	0.4
Bond Creek	9,630	1.3
Hall Creek	6,720	0.9
b. Minor tributaries & immediate drainage (non-point load) -	98,920	12.8
c. Known municipal STP's - None	-	-
d. Septic tanks* -	1,990	0.3
e. Known industrial - None	-	-
f. Direct precipitation** -	11,715	1.5
Total	770,190	100.0

2. Outputs -

Lake outlet - Swan River 894,800

3. Net annual N loss - 124,610 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Swan River	10	450
Johnson Creek	2	104
Bond Creek	9	491
Hall Creek	9	555

* Estimate based on 180 dwellings and one campground; see Working Paper No. 175.
** See Working Paper No. 175.

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Sixmile Creek	0.015	0.780
Groom Creek	0.017	0.795

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	1.56	0.65	70.99	loss*

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Swan Lake:

"Dangerous" (eutrophic loading)	1.84
"Permissible" (oligotrophic loading)	0.92

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the lake, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, unknown and unsampled point sources discharging directly to the lake, or underestimation of the septic tank nitrogen loads. Whatever the cause, a similar nitrogen loss has occurred at Shagawa Lake, Minnesota, which has been intensively studied by EPA's former National Eutrophication and Lake Restoration Branch (Malueg et al., 1975).

V. LITERATURE REVIEWED

Horpestad, Abe, 1975. Personal communication (lake morphometry). MT Dept. of Health & Env. Sci., Helena.

Malueg, Kenneth W., D. Phillips Larsen, Donald W. Schults, and Howard T. Mercier; 1975. A six-year water, phosphorus, and nitrogen budget for Shagawa Lake, Minnesota. Jour. Environ. Qual., vol. 4, no. 2, pp. 236-242.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	SOO-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
3001	CANYON FERRY RESERVOIR	0.047	0.170	442.800	5.816	14.400	0.029
3002	CLARK CANYON RESERVOIR	0.044	0.160	398.750	2.375	12.000	0.027
3003	FLATHEAD LAKE	0.004	0.050	267.833	1.273	9.000	0.004
3004	GEORGETOWN RESERVOIR	0.022	0.040	367.333	6.983	10.200	0.011
3005	HEBGEN RESERVOIR	0.022	0.040	367.700	4.083	13.800	0.020
3006	KOOCANUSA RESERVOIR	0.045	0.100	337.643	2.669	10.400	0.044
3007	MARY RONAN LAKE	0.020	0.040	371.091	4.673	14.200	0.006
3008	MC DONALD LAKE	0.006	0.180	190.667	0.467	6.400	0.002
3009	NELSON RESERVOIR	0.029	0.075	456.750	7.233	11.400	0.007
3010	SEELEY LAKE	0.015	0.040	362.857	2.171	13.200	0.010
3011	SWAN LAKE	0.010	0.050	282.750	3.289	9.600	0.004
3012	TALLY LAKE	0.011	0.050	334.167	2.083	9.200	0.004
3013	TIBER RESERVOIR	0.018	0.180	448.555	2.806	9.600	0.004
3014	TONGUE RIVER RESERVOIR	0.051	0.050	474.111	16.878	13.600	0.008
3016	WHITEFISH LAKE (LOWER)	0.008	0.040	290.000	1.400	7.600	0.003

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
3001	CANYON FERRY RESERVOIR	14 (2)	14 (2)	21 (3)	21 (3)	0 (0)	7 (1)	77
3002	CLARK CANYON RESERVOIR	7 (1)	21 (3)	29 (4)	64 (9)	36 (5)	14 (2)	171
3003	FLATHEAD LAKE	89 (12)	61 (8)	93 (13)	93 (13)	86 (12)	75 (9)	497
3004	GEORGETOWN RESERVOIR	39 (5)	79 (10)	50 (7)	14 (2)	57 (8)	29 (4)	268
3005	HEBGEN RESERVOIR	39 (5)	79 (10)	43 (6)	36 (5)	14 (2)	21 (3)	232
3006	KOOCANUSA RESERVOIR	21 (3)	29 (4)	71 (10)	57 (8)	50 (7)	0 (0)	228
3007	MARY RONAN LAKE	50 (7)	96 (13)	36 (5)	29 (4)	7 (1)	57 (8)	275
3008	MC DONALD LAKE	100 (14)	4 (0)	100 (14)	100 (14)	100 (14)	100 (14)	504
3009	NELSON RESERVOIR	29 (4)	36 (5)	7 (1)	7 (1)	43 (6)	50 (7)	172
3010	SEELEY LAKE	64 (9)	96 (13)	57 (8)	71 (10)	29 (4)	36 (5)	353
3011	SWAN LAKE	79 (11)	46 (6)	86 (12)	43 (6)	68 (9)	75 (9)	397
3012	TALLY LAKE	71 (10)	61 (8)	64 (9)	79 (11)	79 (11)	75 (9)	429
3013	TIBER RESERVOIR	57 (8)	4 (0)	14 (2)	50 (7)	68 (9)	75 (9)	268
3014	TONGUE RIVER RESERVOIR	0 (0)	46 (6)	0 (0)	0 (0)	21 (3)	43 (6)	110
3016	WHITEFISH LAKE (LOWER)	89 (12)	79 (10)	79 (11)	86 (12)	93 (13)	93 (13)	519

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3016	WHITEFISH LAKE (LOWER)	519
2	3008	MC DONALD LAKE	504
3	3003	FLATHEAD LAKE	447
4	3012	TALLY LAKE	429
5	3011	SWAN LAKE	397
6	3010	SEELEY LAKE	353
7	3007	MARY RONAN LAKE	275
8	3013	TIBER RESERVOIR	268
9	3004	GEORGETOWN RESERVOIR	268
10	3005	HEBGEN RESERVOIR	232
11	3006	KOOCANUSA RESERVOIR	228
12	3009	NELSON RESERVOIR	172
13	3002	CLARK CANYON RESERVOIR	171
14	3014	TONGUE RIVER RESERVOIR	110
15	3001	CANYON FERRY RESERVOIR	77

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MONTANA 04/05/76

LAKE CODE 3011 SWAN LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 1737.9

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3011A1	1737.9	13.51	12.91	15.26	43.04	82.69	93.16	45.02	19.00	14.89	15.80	16.57	16.14	32.39
3011A2	1416.7	13.59	13.03	15.29	42.48	82.12	93.45	45.31	18.97	15.01	15.86	15.86	16.14	32.31
3011B1	31.3	0.085	0.071	0.051	0.028	0.023	0.028	0.283	0.566	0.566	0.283	0.113	0.085	0.183
3011D1	19.6	0.071	0.071	0.085	0.566	2.407	1.274	0.425	0.170	0.142	0.170	0.170	0.142	0.477
3011F1	12.1	0.085	0.085	0.099	0.425	1.557	0.793	0.453	0.340	0.142	0.113	0.099	0.085	0.358
3011ZZ	277.6	0.20	0.17	0.20	1.27	4.53	2.55	1.13	0.57	0.42	0.42	0.34	0.28	1.01

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 1737.9
SUM OF SUB-DRAINAGE AREAS = 1757.4

TOTAL FLOW IN = 411.32
TOTAL FLOW OUT = 388.00

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3011A1	10	74	14.385	5	15.857				
	11	74	14.102	3	12.743				
	12	74	12.493	7	12.176				
	1	75	13.281	4	11.610				
	2	75	12.035	1	12.743				
	3	75	12.261	2	11.893	16	11.893		
	4	75	21.039	5	10.732				
	5	75	64.619						
	6	75	122.867	5	143.566	7	144.416		
	7	75	73.879						
	8	75	25.570	12	22.653				
	9	75	19.769	6	23.786				
3011A2	1	74	15.291	4	13.875				
	2	74	14.725	1	13.592				
	3	74	14.725	2	14.725	16	0.0		
	4	74	25.032						
	5	74	76.455						
	10	74	18.406	5	19.822				
	11	74	17.556	3	15.857				
	12	74	15.291	7	15.574				
	6	75	101.091	5	127.426	7	127.426		
	7	75	58.333						
	8	75	21.238	12	22.087				
	9	75	18.123	6	21.238				

TRIBUTARY FLOW INFORMATION FOR MONTANA 08/05/76

LAKE CODE 3011 SWAN LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3011B1	10	74	0.079	5	0.085				
	11	74	0.068	3	0.071				
	12	74	0.045	7	0.057				
	1	75	0.028	4	0.028				
	2	75	0.020	1	0.0				
	3	75	0.025	2	0.014	16	0.063		
	4	75	0.142	5	0.142				
	5	75	0.481						
	6	75	0.708	5	0.991	7	0.991		
	7	75	0.425						
	8	75	0.142	12	0.113				
	9	75	0.113	6	0.113				
3011D1	10	74	0.170	5	0.227				
	11	74	0.156	3	0.156				
	12	74	0.113	7	0.156				
	1	75	0.071	4	0.071				
	2	75	0.065	1	0.0				
	3	75	0.057	2	0.0	16	0.0		
	4	75	0.283	5	0.057				
	5	75	2.265						
	6	75	1.699	5	2.124				
	7	75	0.708						
	8	75	0.227	12	0.198				
	9	75	0.184	6	0.198				
3011F1	10	74	0.108	5	0.113				
	11	74	0.096	3	0.099				
	12	74	0.079	7	0.085				
	1	75	0.093	4	0.085				
	2	75	0.091	1	0.0				
	3	75	0.085	2	0.085	16	0.085		
	4	75	0.227	5	0.0				
	5	75	1.303						
	6	75	1.048	5	1.416	7	1.416		
	7	75	0.736						
	8	75	0.425	12	0.453				
	9	75	0.198	6	0.283				

12

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/05

301101
48 00 20.0 113 57 38.0 3
SWAN LAKE
30029 MONTANA
130291

11EPALES 2111202
0060 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/06/02	15 20	0000	10.4	9.8	144	130	8.20	59	0.020K	0.500	0.020K	0.012
	15 20	0005	10.4	9.8		129	8.15	89	0.020K	0.300	0.030	0.011K
	15 20	0025	10.2	10.0		126	8.05	91	0.020K	0.300	0.030	0.011K
	15 20	0040	9.2	9.2		124	7.90	96	0.020K	0.300	0.050	0.011K
	15 20	0056	5.9	9.8		124	8.20	90	0.020K	0.200	0.040	0.005
75/07/28	10 20	0000	17.2	8.4	216	123	8.25	74	0.020K	0.200K	0.020K	0.004
	10 20	0005	17.1	8.2		122	8.20	75	0.020K	0.200K	0.020K	0.004
	10 20	0025	16.5	8.0		124	8.00	75	0.020K	0.200K	0.020K	0.004
	10 20	0035	11.7	8.4		112	7.90	77	0.020	0.200K	0.030	0.003
	10 20	0055	7.3	5.4		112	7.60	88	0.020	0.200	0.100	0.008
75/09/05	14 50	0000	15.8	9.0	280	130	8.15	83	0.020K	0.200K	0.020K	0.002K
	14 50	0005	15.3	8.8		129	8.15	85	0.020K	0.200	0.020K	0.004
	14 50	0020	15.2	8.6		129	8.10	84	0.020K	0.200K	0.020K	0.002K
	14 50	0033	15.1	9.0		129	8.10	85	0.020K	0.200K	0.020K	0.002K
	14 50	0047	11.2	6.2		119	7.80	87	0.020K	0.300	0.020K	0.003

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/06/02	15 20	0000	0.021	1.3	
	15 20	0005	0.009		
	15 20	0025	0.009		
	15 20	0040	0.008		
	15 20	0056	0.013		
75/07/28	10 20	0000	0.006	1.0	
	10 20	0005	0.005		
	10 20	0025	0.005		
	10 20	0035	0.007		
	10 20	0055	0.011		
75/09/05	14 50	0000	0.010	1.9	
	14 50	0005	0.011		
	14 50	0020	0.011		
	14 50	0033	0.009		
	14 50	0047	0.041		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

301102
47 58 03.0 113 54 33.0 3
SWAN LAKE
30029 MONTANA

130291

11EPALES 2111202
0062 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 OO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/06/02	15 50	0000	11.1	9.8	90	127	8.20	87	0.020K	0.200	0.030	0.004
	15 50	0005	10.7	9.8		127	8.20	86	0.020	0.300	0.040	0.004
	15 50	0015	9.9	10.0		123	8.00	93	0.020	0.300	0.040	0.010J
	15 50	0040	8.1	9.4		123	7.90	95	0.030	0.300	0.060	0.006
	15 50	0058	5.9	9.6		122	8.10	86	0.020K	0.200	0.040	0.010J
75/07/28	09 50	0000	16.3	8.2	216	123	8.20	74	0.020	0.200K	0.020	0.003
	09 50	0005	16.2	8.4		123	8.25	74	0.020K	0.200K	0.020K	0.004
	09 50	0020	16.1	8.4		123	8.20	74	0.020	0.200K	0.020K	0.003
	09 50	0030	12.3	8.2		113	7.90	75	0.020K	0.200K	0.030	0.003
	09 50	0051	6.8	8.2		116	8.20	77	0.020K	0.200K	0.020	0.004
75/09/05	14 25	0000	15.7	7.4	300	133	8.00	82	0.020K	0.200K	0.020K	0.002K
	14 25	0005	15.5	7.4		133	8.10	84	0.020K	0.200K	0.020K	0.002K
	14 25	0025	14.8	9.0		131	8.15	84	0.020K	0.200K	0.020K	0.002K
	14 25	0033	14.7	8.8		129	8.10	84	0.020K	0.200K	0.020K	0.002K
	14 25	0061	10.7	7.0		121	7.80	87	0.020K	0.200K	0.040	0.002K

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/06/02	15 50	0000	0.009	1.0	
	15 50	0005	0.010		
	15 50	0015	0.010		
	15 50	0040	0.009		
	15 50	0058	0.010		
75/07/28	09 50	0000	0.006	1.5	
	09 50	0005	0.007		
	09 50	0020	0.008		
	09 50	0030	0.007		
	09 50	0051	0.009		
75/09/05	14 25	0000	0.009	10.0	
	14 25	0005	0.011		
	14 25	0025	0.010		
	14 25	0033	0.010		
	14 25	0061	0.028		

K= VALUE KNOWN TO BE LESS THAN INDICATED

J= VALUE KNOWN TO BE IN ERROR

42

STORET RETRIEVAL DATE 76/08/05

361103
47 55 20.0 113 51 28.0 3
SWAN LAKE
30029 MONTANA

130291

11EPALES 2111202
0084 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/06/02	16 15	0000	11.5	10.0		130	8.10	86	0.020K	0.300	0.040	0.012K
	16 15	0005	11.1	9.8		128	8.10	89	0.020	0.300	0.040	0.011K
	16 15	0015	8.6	9.6		122	8.00	91	0.020K	0.200	0.050	0.011K
	16 15	0035	6.7	9.8		115	7.90	92	0.020	0.200K	0.050	0.005
	16 15	0050	5.6	9.2		114	7.80	96	0.020K	0.200	0.050	0.012J
	16 15	0080	4.3	9.8		120	8.10	87	0.020	0.300	0.040	0.004
75/07/28	09 15	0000	18.2	8.0	228	130	8.20	81	0.020	0.200K	0.020K	0.004
	09 15	0005	17.3	8.8		130	8.20	71	0.030	0.200K	0.020	0.003
	09 15	0020	13.3	9.0		114	8.10	70	0.020	0.200K	0.020K	0.003
	09 15	0035	10.5	8.2		106	7.80	68	0.020	0.200K	0.040	0.004
	09 15	0060	6.2	8.4		104	7.75	80	0.020	0.200K	0.060	0.004
	09 15	0085	3.9	7.6		115	7.65	94	0.020K	0.200K	0.080	0.005
75/09/05	14 05	0000	15.4	9.0	264	134	8.40	92	0.020K	0.200K	0.020K	0.002K
	14 05	0005	15.6	8.8		133	8.20	92	0.020K	0.200K	0.020K	0.002K
	14 05	0032	13.4	9.2		125	8.00	91	0.020K	0.200K	0.020K	0.002K
	14 05	0050	10.7	7.8		129	7.80	87	0.020K	0.200K	0.040	0.002K
	14 05	0072	7.8	6.0		147	7.10	85	0.020K	0.200	0.080	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/06/02	16 15	0000	0.010	1.7	
	16 15	0005	0.008		
	16 15	0015	0.010		
	16 15	0035	0.010		
	16 15	0050	0.016		
	16 15	0080	0.010		
75/07/28	09 15	0000	0.013	1.4	
	09 15	0005	0.005		
	09 15	0020	0.012		
	09 15	0035	0.014		
	09 15	0060	0.029		
	09 15	0085	0.012		
75/09/05	14 05	0000	0.007	1.8	
	14 05	0005	0.007		
	14 05	0032	0.006		
	14 05	0050	0.007		
	14 05	0072	0.041		

K* VALUE KNOWN TO BE LESS THAN INDICATED

J* VALUE KNOWN TO BE IN ERRO-

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/08/05

3011#1
48 32 00.0 113 58 30.0 4
SWAN RIVER
30 7.5 CRATER LAKE
O/SWAN LAKE 130291
SEC RD BRDG .7 MI W OF JCT W FAS HWY 209
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	18 40		0.015	0.150	0.005K	0.005K	0.010K
74/11/03	10 55		0.008	0.400	0.020	0.005K	0.010K
74/12/07	14 30		0.00K	0.100K	0.010	0.005K	0.010K
75/01/04	11 30		0.016	1.200	0.005	0.005K	0.010K
75/02/01	11 30		0.032	1.700	0.016	0.008K	0.010K
75/03/02	11 00		0.040	0.550	0.016	0.008K	0.010K
75/03/16	11 30		0.032	0.800	0.024	0.008K	0.010K
75/04/05	14 30		0.035	2.400	0.040	0.005K	0.010K
75/06/05	09 40		0.025	0.250	0.005K	0.005K	0.010K
75/06/07	10 30		0.030	1.700	0.020	0.005K	0.010K
75/08/12	14 00		0.005	0.550	0.025	0.005	0.010K
75/09/04	15 30		0.035	0.400	0.010	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

27

STORET RETRIEVAL DATE 76/08/05

301142
47 55 30.0 113 52 52.0 4
SWAN RIVER
30 7.5 YEW CREEK
T/SWAN LAKE 130291
BNK 4.1 MI NW OF JCT WITH FAS HWY 209
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	16	15	0.024	0.100	0.005K	0.005K	0.010K
74/11/03	14	00	0.024	0.100	0.015	0.005K	0.010K
74/12/07	11	30	0.048	0.100K	0.010	0.005K	0.010K
75/01/04	15	00	0.056	1.100	0.005	0.005K	0.010K
75/02/01	14	30	0.064	1.300	0.024	0.005K	0.010K
75/03/02	15	00	0.048	0.650	0.024	0.005K	0.010K
75/06/05	12	00	0.050	0.450	0.005K	0.005K	0.020
75/06/07	14	30	0.055	0.700	0.010	0.005K	0.020
75/08/12	16	00	0.020	0.550	0.030	0.005	0.010
75/09/06	14	45	0.025	0.600	0.005K	0.005K	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

301101
48 01 17.0 113 58 40.0 4
JOHNSON CREEK
30 7.5 CRATER LAKE
T/SWAN LAKE 130291
BRDG 1.3 MI NW OF JCT WITH FAS HWY 209
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	18 30		0.012	0.200	0.005K	0.005	0.010K
74/11/03	11 30		0.008	0.100K	0.015	0.005	0.010K
74/12/07	14 30		0.008	0.100K	0.010	0.005K	0.010K
75/01/04	12 00		0.016	1.100	0.005	0.005K	0.010K
75/03/02	11 30		0.032	0.550	0.024	0.008K	0.010
75/03/16	12 00		0.024	2.000	0.016	0.008K	0.010
75/04/05	14 45		0.010	0.800	0.015	0.005K	0.010
75/06/05	10 00		0.015	0.550	0.005K	0.005	0.010
75/06/07	10 40		0.020	0.400	0.005	0.005	0.010
75/08/12	14 30		0.010	0.075	0.012	0.032	0.032
75/09/06	15 45		0.010	0.250	0.005K	0.005	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

3011C1
47 59 20.0 113 55 22.0 4
SIXMILE CREEK
30 7.5 YEW CREEK
T/SWAN LAKE 130291
FAS HWY 209 BRDG 6 MI NW OF TWN SWAN LK
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	18 00		0.004	0.100K	0.005	0.005	0.010
74/11/03	12 00		0.008	0.100K	0.010	0.005	0.010K
74/12/07	13 30		0.008	0.100K	0.010	0.005K	0.010K
75/01/04	12 30		0.024	1.600	0.010	0.005	0.010K
75/03/02	12 00		0.024	1.050	0.016	0.008K	0.020
75/03/16	13 00		0.008	0.650	0.016	0.008K	0.010
75/04/05	15 50		0.010	1.750	0.035	0.005	0.010K
75/06/05	10 15		0.010	0.450	0.005K	0.005	0.010
75/06/07	11 30		0.015	0.675	0.005K	0.010	0.010
75/08/12	15 00		0.020	1.100	0.020	0.035	0.050
75/09/06	12 15		0.025	0.350	0.015	0.005	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

30

STORET RETRIEVAL DATE 76/08/05

301101
47 55 16.0 113 49 59.0 4
BOND CREEK
30 7.5 SWAN LAKE
T/SWAN LAKE 130291
UNMPRVD RD XING .3 M E JCT & FAS HWY 209
11EPALES 2111204
0000 FEET DEPTH CLASS 00

31

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	17 00		0.012	0.200	0.005K	0.005K	0.010K
74/11/03	13 30		0.032	0.100K	0.015	0.005K	0.010K
74/12/07	12 00		0.056	0.100K	0.060	0.005K	0.010K
75/01/04	14 00		0.080	1.100	0.005K	0.005K	0.010K
75/04/05	15 30		0.070	1.250	0.020	0.005K	0.010K
75/06/05	11 30		0.165	1.000	0.005K	0.005K	0.010K
75/08/07	12 20		0.170	0.100	0.005K	0.005K	0.010K
75/08/12	16 00		0.350	0.150	0.015	0.030	0.030
75/09/06	15 00		0.055	0.550	0.020	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/08/05

3011E1
47 56 00.0 113 50 37.0 4
GROOM CREEK
30 7.5 SWAN LAKE
T/SWAN LAKE 130291
SEC RD XING JUST N OF TOWN OF SWAN LAKE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/06/05	11 15		0.280	0.850	0.005K	0.005K	0.010K
75/06/07	12 10		0.290	0.850	0.005K	0.005K	0.010K
75/08/12	15 30		0.065	0.050K	0.005K	0.030	0.030

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

3011F1
47 56 17.0 113 50 25.0 4
HALL CREEK
30 7.5 SWAN LAKE
T/SWAN LAKE 130291
UNMPRVD RD XING .7 M E JCT # FAS HWY 209
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	17 30		0.016	0.300	0.005K	0.005K	0.010K
74/11/03	12 30		0.016	0.100K	0.010	0.005K	0.010K
74/12/07	13 00		0.032	0.100	0.010	0.005K	0.010K
75/01/04	13 00		0.048	1.600	0.005	0.005K	0.010K
75/03/02	14 00		0.072	0.950	0.024	0.008K	0.010K
75/03/16	14 30		0.064	0.200	0.008	0.008K	0.010K
75/06/05	11 00		0.085	0.500	0.005K	0.005K	0.010K
75/06/07	12 00		0.100	1.050	0.318	0.005K	0.010K
75/08/12	15 00		0.040	0.050K	0.005	0.030	0.030
75/09/06	13 15		0.045	0.550	0.025	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

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